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SOIL AND WATER CONSERVATION AND PLANT - SOIL RELATIONSHIPS IN THE SOUTHWEST

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SOIL AND WATER CONSERVATION
AND PLANT -- SOIL RELATIONSHIPS
IN THE SOUTHWEST

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Vegetation probably expresses the summation of environment better than any recording device that will ever be developed; therefore, the plant cover reflects the degree of soil development, and in arid or semi-arid regions, the effectiveness of rainfall.

Soil depletion is always reflected by a change in vegetation. A vegetative association not only develops in response to a specific environment, but is at the same time the expression and indication of the same. Changes in vegetation reflect the degree of soil depletion from erosion; also, the degree of restoration after depletion, and the efficiency of erosion control techniques employed. Soil and water conservation on the badly depleted and eroded overgrazed areas of the Southwest depends largely upon the restoration of the original vegetative cover. Natural revegetation proceeds slowly through a definite series of plant successions on each soil type, the climax for the region being developed coincident with the maturity of the soil type. Knowledge of such succession in relation to erosion control and moisture conservation is necessary to develop the most economical and practical methods.

Knowledge of succession entails not only the sequence of vegetative types, but also the intricate relationships of the associated species in each successive stage to each other, and to the soil origin, texture, structure, depth, degree of maturity, and other factors influencing vegetative development. Some plants have rather general preferences for certain factors and specific preferences for other. If it were possible to determine the needs of every single species, its occurrence in a given location would tell us within the limits of its tolerance the amount and quality of each habitat factors which contributed to its development. Such information not being available or obtainable with present methods, we must confine our attention to species which have a distinct preference for one factor or combination of factors, or plants within a community which in their association together indicate specific preferences because of such association.

As previously mentioned, one of the more important factors of environment that influences type of plant cover is the condition or type of soil. The soil is not a static natural body, but one that is constantly developing or changing until it comes into general equilibrium with climate, vegetation, and other environmental conditions. Changes in either the vegetative cover, climater, or soil conditions produce environmental conditions to which either the soil or plant must adjust itself. It is apparent, therefore, that, under a given climate, progression or

regression of soils or plants is interdependent, and development or degeneration of each is coincident.

There are in any climate soils that have been recently deposited, or that, for other reasons, are undeveloped, and, therefore, do not have the chemical, physical, or biological properties of a mature soil under the existing environment. Due to different periods or rates of deposition or erosion, or exposure of parent rock, soils of varying stages of maturity can, therefore, be found in any region. In general the degree of maturity of a soil can be judged by the development of the "B" horizon or subsoil. In the process of soil development, the finer soil particles and mobile organic or soluble chemical constituents move downward with percolating rainwater to relatively slight depth, resulting in the gradual formation of a heavier textured or chemically enriched "B" horizon.

On undeveloped soils, or those which have been depleted by overgrazing, trampling, and consequent erosion, a very early stage in succession will be represented by a thin stand of annual weeds. Undeveloped soils containing high percentages of clay and collodial materials usually have sufficient quantities of such materials in the unleached surface to retard the rate of moisture penetration, and, consequently, to also limit the amount of water absorbed during any limited period of precipitation. Undeveloped soils with a coarse texture, even though

moisture penetrates them readily, are not capable of retaining sufficient moisture within the zone of root occupation to support a more advanced stage of succession. The soils which have been depleted by overgrazing and trampling have had their ability to absorb water destroyed by the removal of varying degrees of the permeable surface. The remaining surface, or exposed subsoil, has been rendered impervious by compaction, and the sealing up of root channels and other pore spaces. In any of the above conditions only sufficient moisture is absorbed and retained to support a sparse annual growth, which can complete its life cycle within the period of the growing season having the heaviest precipitation.

On the coarse textured undeveloped soils breaking up of the coarser particles, the translocation of these particles to the subsoil, and accumulation of organic material will provide storage capacity for increasing amounts of moisture. On the heavier-textured undeveloped soils, and the depleted soils roots and various forms of macro and micro organisms tend to loosen up the soil mass. In addition, the accumulation of vegetative debris checks the runoff and gives moisture more time to be absorbed. The above processes will give rise to better soil development and a second stage in the succession characterized by a heavy growth of the same weeds with the advent of a few annual grasses. In the next stage of the succession, the annual grasses will largely

displace the weeds, and in turn deep rooted perennials will begin to obtain a foothold because of soil conditions encouraging deeper water penetration.

The next stage in the succession will consist largely of relatively deep rooted perennial shrubs with an increasing percentage of pioneer perennial grasses.

In the final stage of the succession as the soil matures or as regeneration nears completion on a depleted soil, the vegetation approaches the climatic terminal community or climax.

The density, composition, and volume growth of the vegetative cover quite commonly, however, does not express the maximum development possible under given climatic conditions because of undeveloped or eroded soils.

Climax grasses of the desert grasslands are characterized by a dual root system. The major portion of this system consists of widely spread, finely branched roots that thoroughly impregnate the surface few inches of the soil. This arrangement facilitates the rapid absorption of the infrequent light rains before they are dissipated because of the high evaporation rate characteristic of this habitat. The minor portion of the root system consists of roots that more or less thoroughly occupy the soil mass to a depth of approximately four feet. The grass plant is able to sustain itself through the long protracted drought periods by drawing upon the stored water in this zone.

By intercepting the water as it enters the surface soil, the roots of climax grasses effectively cut off the moisture supply to the deeper soil layers, and the deep root systems of the pioneers, or invaders upon depletion of a former climax. The deep, sparsely branched root systems of the perennial shrub stage are no longer effective in supplying water to the plants. Dead roots of the pioneers or invaders are often encountered under climax grass covers that have developed in periods of one to three decades.

The root systems of climax grasses have developed in harmony with a type of soil development which allows them to utilize the factors of the habitat for maximum ground coverage and foliage production. The effectiveness of the climax cover for protection against wind and water erosion is demonstrated by the maturing of the soil coincident with the development of the climax.

Stock Water Development

A careful investigation of the vegetation and soils should precede the location of any water development, in order that the stock water development will cause the least possible damage to the vegetative cover.

Thorough investigation of the plant-soil relationships will determine the ability of the soil to maintain a vegetative cover with a minimum of denudation and depletion under the increased grazing and trampling that will accompany establishment of the

watering place. The added trampling and grazing will not materially affect the original grass cover upon many soils, either in decreasing the density or the introduction of noxious and poisonous species; but upon some soils, the result will be an area of drifting sand and a woody or denuded area of large extent.

Adjacent different soil types which may have originally supported practically the same composition and density of vegetative cover do not become depleted at the same rate under the same degree of overgrazing. Several instances have been observed where blue and black grama grass roots have been shortened by overgrazing from a maximum depth ranging between 48 and 51 inches to a maximum depth of 19 to 21 inches. On soil types where the shortened and restricted roots of overgrazed grass plants do not extend into a heavier-textured "B" horizon, the grass is soon thinned out and replaced by unpalatable species of little erosion control value. But on soil types where a heavier-textured "B" horizon exists within reach of the roots of the dominant grass of the area, even when the root systems are materially shortened by overgrazing, the grass will be able to withstand the over-utilization with a minimum of harm. This is especially true if a rotation plan is practiced in stock management so that the grass plants can store up a food reserve. The location of watering and salting places upon soil types that can best withstand heavy usage will result in a lighter impact of grazing upon soil types least able to withstand it. A

more uniform erosion resistant cover over an entire area will be the result of such practices.

Mechanical Measures

Any mechanical erosion control measure instituted with a view of increasing the vegetative cover, or whose most effective operation depends upon vegetation, should be attempted only after careful consideration of the plant-soil relationships. The rate of water penetration, the water-holding capacity, the depth of root penetration, and general feeding level of the roots of the dominant species are all factors that must be known, and the control measures designed so that the maximum benefit may be derived from the structure for soil and water conservation and increased forage production.

Mechanical erosion control measures that put more water into the soil, in addition to controlling erosion, will improve and increase the vegetative cover, or augment the underground water supply or both. The ultimate effect of the treatment will depend upon the character of the bedrock and various soil characteristics, a few of the most important soil features being texture, structure, organic matter, PH, and depth.

The areas upon which erosion control measures will produce the best results in increasing vegetative cover are generally characterized by a grass association. The dominants of these

associations in Region 8 are commonly blue grama, black grama, and galleta. These grasses exhibit their best development on moderately to maturely developed soils where there is evident profile development. The "B" horizon is noticeably heavier textured, and there are varying degrees of lime accumulation in the subsoil. The depth of the clay concentration is determined by the average maximum water concentration and is coincident with the general feeding level of grass roots.

An erosion control structure that retains more than sufficient water to moisten the zone of grass root occupation is not the most efficient for erosion control because the deeply penetrating moisture is only available to deep rooted species which have relatively few sparsely branched lateral roots and are not highly effective soil binders. On the finer-textured soils sufficient moisture cannot be retained to moisten the zone of root occupation at one time as the rate of infiltration is so slow that a sufficient amount of water would stand on the surface more than 36 hours. The grasses mentioned above are not able to withstand free water standing on the surface for a longer period than this without injury. Structures built for the purpose of stimulating and maintaining the grass cover should not provide for penetration below depths between 36 and 48 inches, as moisture below this range is not available to the above grasses.

The following averages from 10 to 15 soils of Region 8

in each textural class indicate within broad limits their capacities to absorb and hold moisture. Soils included were relatively free from deflocculating salts which materially decrease the rate of percolation.

	Depth 1 inch of rain will penetrate	Inches of rain necessary to wet soil 48" deep	Inches of water percolation per hour	Approximate time necessary for water to penetrate 48" - hours
Sand	9"	5	9	.55
Sandy Loam	7"	7	2.5	2.8
Silt Loam	5"	9	1	9
Clay Loam	3"	16	.2	80

From the above, it is evident that more than 5 inches of water retained by a structure on a sandy soil will be of no benefit to grass. On a sandy loam 7 inches may be retained, and on a silt loam 9 inches may be held, but on a clay loam only 7 inches may be safely detained even though this amount will penetrate less than 24 inches because a greater amount would cause free water to stand on the surface more than 36 hours.

Any erosion control measure which denudes wide strips of soil is not desirable because of the protective effect of a vegetative cover. The small frequent structure which disturbs only a narrow strip of vegetation, beneath which roots of undisturbed grass plants remain, which hold only a sufficient amount of water to be absorbed within the zone of root occupation, and which hold no more water than can be absorbed within a period

of 36 hours, will result in the greatest vegetative growth. Proper spacing will be determined by slope, soil texture, and vegetative cover.

Carrying Capacities

Vegetation is not able to withstand equal utilization on different soil types. Well-developed soils with a permeable surface and a subsoil with moderate clay content within the general feeding level of grass roots can withstand much more severe usage without deterioration and will recover more quickly under the same usage or make recovery under heavier usage than soils with an impervious surface, or ones which have a coarse texture throughout.

The well-developed soil will absorb water readily and store it within the general feeding level of grass roots. Here rainfall attains its highest efficiency, maintains the greatest density, and yields the greatest volume of growth. Soils with an impervious surface absorb very little moisture, while in those immature soils that are coarse textured throughout, moisture soon escapes to depths below the feeding zone of the grass roots. In soils having these characteristics, rainfall has a very low efficiency; grass roots are shortened rapidly under overgrazing, and give way very soon to annuals in the case of impervious soils, or to deep-rooted woody or unpalatable perennials in the case of coarse-

textured soils. A soil with a coarse texture throughout the profile may be able to hold sufficient moisture to sustain a good stand of grass under high rainfall, but it will withstand very little usage because the soil mass occupied by the shortened and restricted root systems of heavily used grass plants cannot hold enough moisture to maintain the grass stand through prolonged drought periods. The latter two soils will need lighter stocking to make an appreciable recovery than would be the case with the first soil mentioned.

The frequency and degree of grazing which will yield the greatest sustained yield of forage through a period of years is, also, the frequency and degree of grazing which will maintain the greatest plant vigor; that this will vary with different soil types is beyond question.

Best results from the grass cover for soil and water conservation and forage production can only be obtained when full recognition is given plant-soil relationships in the formulation of range management plans. A careful consideration of soil relationships is as necessary in the production of natural vegetation as in the production of cultivated crops.

Natural and Artificial Revegetation

Nature is prodigal in supplying seed for maintaining or reestablishing itself. Nature as well has placed plants in

those positions, by selection and survival of the fittest, where they are best fitted to grow, flower, fruit, seed, and maintain their dominance. The establishment and maintenance of a species presupposes the ability of the plant to produce viable germules and also a habitat that encourages their establishment. Granting the above premises, if as little as one percent density of the original desirable vegetation remains, it will probably be able to re-establish itself when a suitable combination of favorable conditions occurs. The combination of conditions necessary to materially increase a species might probably be an abundant supply of moisture one year to produce a plentiful supply of good viable seed, followed by a season of sufficient moisture not only to germinate but to maintain the seedling until it can become established.

In artificial revegetation viable seed is present, but there is no assurance that conditions for the successful germination and establishment of the plants will follow. It is quite probable that such a combination of conditions may not occur for as long a period as a decade. It is advisable, therefore, that no attempt be made at artificial reseeding of a species that is present in any appreciable amount.

If the original cover is not present in any appreciable amount, it would not appear feasible to reseed to that particular species, but to some subclimax type, as the destruction of a habitat suitable for maintaining a climax usually accompanies the